TE-CDP: A Backup System Based on the Twin-Engin Continuous Data Protection

Yongjian Ren*1, Haoze Jiang2, Jilin Zhang3, Ye Chen4

Department of Computer Science and Technology, Hangzhou Dianzi University, Hangzhou, China

*1yongjian.ren@infocore.cn; 2jianghaoze1@yeah.net; 3jilin.zhang@hdu.edu.cn; 4tom@infocore.cn

Abstract

This paper presents a new backup system named TE-CDP. The new system contains three methods. First of all, we propose the snapshot flow method that based on the twin-engin CDP, by which we make incremental backup of snapshot based on point-in-time. It could save storage space. In addition, in order to ensure the real-time of data protection, we propose the single mirroring method. Last but not the least, because of the poor consistency of snapshot, we present the consistency agent method of CDP, it could ensure the consistency of CDP. The experiment shows TE-CDP is able to protect data and recover snapshot in seconds.

Keywords

The Twin-Engin CDP; Backup and Recovery; Snapshot

Introduction

With the advances in networked information services, data protection and recovery have become a hot topic (Jing Yang et al., 2012; Zhichao Li et al., 2012). Snapshot method ensures data consistency for backup system and CDP is more better then snapshot on backup time lapse granularity.

Nowadays, most backup systems use both snapshot method and CDP. The backup system of Huazhong University of Science and Technology used ST-CDP mechanism to optimize the traditional Timely Recovery to Any Point-in-time (TRAP) architecture (Jing Yang et al., 2012). Nankai University embedded CDP into LVM, they called it SnapCDP (Feng Wang et al., 2009).

But we have the backup problems as follows:

- storage space wasted;
- the poor real-time of data protection;
- the poor consistency of snapshot data.

To solve the above problems, we propose TE-CDP backup system and use three methods:

- Snapshot Flow Method: It's based on the twin-engin CDP (COW and ROW) and It can save storage space by making incremental backup of snapshot based on point-in-time.
- Single Mirroring Method: It avoids I/O competition between TE-CDP and common applications. It also ensures the real-time of data protection when synchronous backup data.
- Consistency Agent Method of CDP: It could ensure the data consistency of CDP.

The paper is organized as follows: We discuss related work in the next section. Section 3 presents the architecture of TE-CDP and introduce the tree methods in our system. Section 4 presents the two major function modules in TE-CDP. Section 5 gives the evalution of TE-CDP. Section 6 concludes our paper and outlooks our furture work.

Related Work

Many scholars promote backup systems by different methods over years.

Some of them promoted their backup systems by improving the efficiency or saving the storage space of CDP system. In (Maohua Lu et al., 2011), a high-performance index update mechanism is presented to reduce the memory resource occupation of the block-level CDP system. In (Xiao Li et al., 2011), convex point SNAPshot (CSNAP) is presented, it takes less than 10% storage space of traditional snapshot method.

Others used deduplication to save storage space. In (Stephen Smaldone et al., 2013), deduplication is used to reduce the space that file system and metadata used when protect the virtual machine. In (Wei Zhang et al., 2013), authors used a low-cost deduplication which reduce the usage of CPU and memory of each VM in the cloud storage backup system.

All these systems didn't consider both storage-saving space of backup system and data consistency of the

system. We present a backup system called TE-CDP. It uses the snapshot flow method to save storage space. The method to make incremental backup of snapshot is based on point-in-time. It ensures the real-time of data protection by using single mirroring method. And it also ensures the consistency of CDP by using consistency agent method of CDP.

System Design

In this section, we discuss the architecture of TE-CDP. We also discuss the backup methods in our system.

The Architecture of TE-CDP

The most difficult thing to design a backup system is that how to ensure correctly and efficiently the data protection and recovery in a limited bandwidth. We use LAN-Free backup idea to design the architecture as shown in Fig. 1.

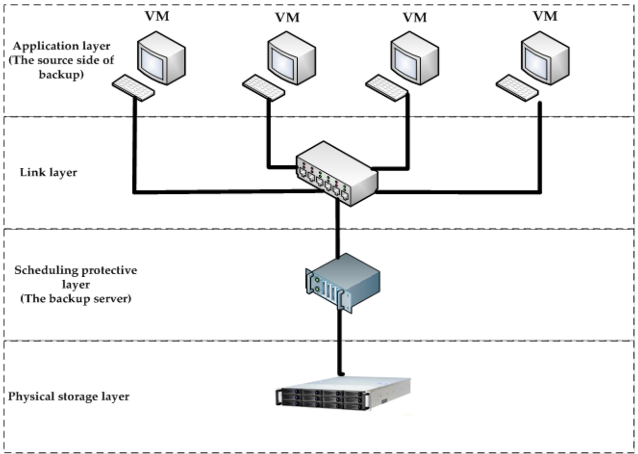

FIG. 1 THE ARCHITECTURE OF TE-CDP

Obviously, TE-CDP has four layers. Application layer (The source side of backup) contains some computers that should be protected. Scheduling protective layer (The backup server) contains function modules of the system. Link layer is usually switchboards or hubs, it's the communication bridge between application layer and scheduling protective layer. Physical storage layer is disks array which map disks to scheduling protective layer.

Snapshot Flow Method

Snapshot flow method is used in the backup server to solve the storage space wasted problem. The method makes incremental backup of snapshot based on point-in-time.

This method is based on the twin-engin CDP. We can set the CDP engine when we add backup and TE-CDP will mark CDP based on CDP engine.

Single Mirroring Method

Single mirroring method is used in the source side of backup to ensure real-time of data protection. It also avoids I/O competition between TE-CDP and common applications.

We design a mechanism for the method which can avoids I/O competition when synchronous backup data. Every I/O request should wait the I/O before it and common applications have the initiative and priority of I/O.

Consistency Agent Method of CDP

Consistency agent method of CDP is also used in the source side of backup. It ensures consistency of CDP.

We design a mechanism which can refresh the cache on disks in the method. When receiving the command from CDP schedule, the listener inform the daemon to refresh the cache on disks and then imform the backup server to mark CDP.

The Major Function Module

This section will introduce two major function modules of TE-CDP: The data protection module and The snapshot recovery module.

The Data Protection Module

In this module, we use the CDP storage volume to store the snapshot. We also use the three methods which introduced in the previous section to achieve the goal of real-time backup and consistency backup.

The module's working process is shown in Fig. 2.

And we also can conclude the process as follows:

1. Apply for the space of CDP storage volume at the backup server.
2. Set the CDP engine of CDP storage volume, which must be the one of COW and ROW.
3. Bind the CDP storage volume with a logical volume at the backup server.
4. Map the logical volume to the source side of backup.
5. Use single mirroring method to synchronous backup data.
6. If the synchronous is completed, the backup server will mark CDP when receive the command from consistency agent.

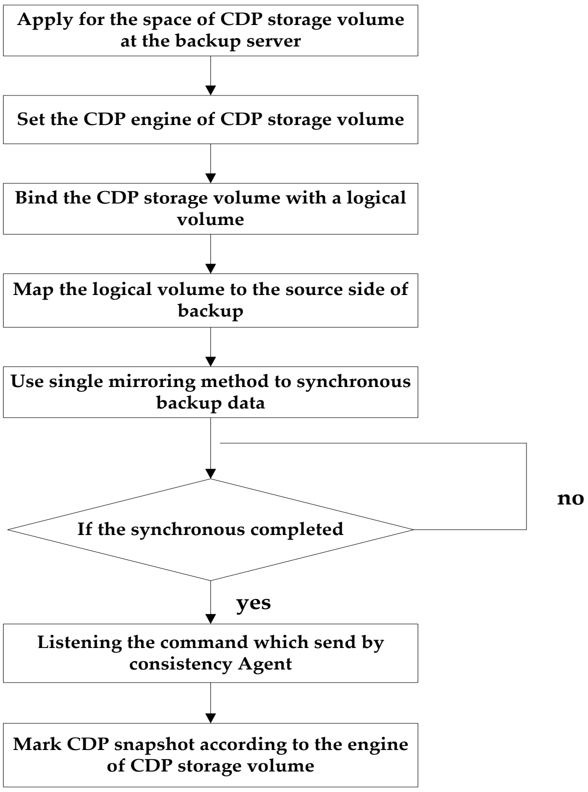

FIG. 2 WORKING PROCESS OF THE DATA PROTECTION MODULE

The Snapshot Recovery Module

This module is based on the CDP engine of CDP storage volume we set. We use the engine's mechanism to recover the appointed snapshot.

The module's working process is shown in Fig. 3.

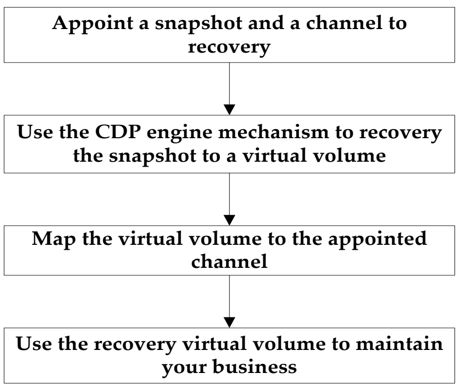

FIG. 3 WORKING PROCESS OF THE SNAPSHOT RECOVERY MODULE

We also can conclude it as follows:

1. Appoint a snapshot to recover the channel where you want to recover..
2. Use the CDP engine mechanism of CDP storage volume to recover the snapshot to a virtual volume.
3. Map the virtual volume to the appointed channel.
4. Use the recovered virtual volume to maintain your business.

Evaluation

Our experiment hardware environment is shown in Table 1.

TABLE 1 THE HARDWARE ENVIRONMENT OF TE-CDP

System Layer	Equipment Type	Hardware Configuration
Application Layer	Infocore Tigler SC8200	Specification: 2U Processor: 2.13GHz (Dual-Core) Memory: 32GB Capacity: 600GB
Link Layer	Voltaire Infiniband	Specification: 1U Link Module: 24 DDR ports
Scheduling Protective Layer	IBM System x3850 X5	Specification: 4U Processor: 2.40GHz (10 cores) Memory: 32GB Capacity: 600GB
Physical Storage Layer	Sugon DS-2120FA6TB	Specification: 2U Capacity: 2TB

We install ESXi 5.3 on the application layer and use a virtual machine whose operating system is RedHat 6.2 as the source side of backup. We use infonix 6.5.1-4 operating system as the backup server.

We compare the used time of adding backup between a 50GB disk and a 100GB disk, each disk test 10 times, the result is shown in Table 2.

TABLE 2 THE USED TIME OF ADD BACKUP

Times	Time of Add Backup (s)	
	50GB	100GB
1	4.058	3.760
2	3.706	3.502
3	3.840	3.814
4	3.957	4.008
5	3.720	3.881
6	3.747	3.677
7	3.921	3.804
8	3.658	3.883
9	3.638	3.588
10	3.863	3.575
average	3.811	3.749

As it shown in Table 2, we can say that add backup for the 50GB disk used about 3.811s and it used about 3.749s for the 100GB disk.

We also compare the used time of snapshot recovery between the two disks, the ID of snapshot is 0, and the

result is shown in Table 3.

As we can see in Table 3, the recover time of the 50GB disk is about 1.661s and the time is about 1.598s of the 100GB disk

TABLE 3 THE USED TIME OF SNAPSHOT RECOVERY

Times	Time of Snapshot Recovery (s)	
	50GB	100GB
1	1.896	1.582
2	1.572	1.584
3	1.544	1.623
4	1.589	1.659
5	1.836	1.706
6	1.678	1.536
7	1.711	1.574
8	1.706	1.571
9	1.536	1.581
10	1.541	1.562
average	1.661	1.598

In summary, our system is able to add backup and recover snapshot in seconds. And disk size can not affect the efficiency of TE-CDP while adding backup or snapshot recovery.

Conclusion and Furture Work

This paper presents a backup system called TE-CDP. The system not only uses snapshot flow method to solve storage-space-wasting problem, but also the single mirroring method to ensure real-time of data protection when synchronous the data. Besides, it also uses consistency agent method of CDP to ensure the consistency of snapshot data.

The experiment result explain that the system can add backup and restore snapshot in seconds and the efficiency of the system would not be influenced when disk size changed.

The system also has a disadvantage, that is, when the system receives multiple commands, the performance of backup server will be reduced. In our furture work, an adaptive algorithm will be presented in which we will consider both server performance and backup efficiency.

ACKNOWLEDGMENT

This paper is supported by National Natural Science Foundation of China under Grant No.61202094, No.61003077, No.60873023, No.60973029, No.11375049, Zhejiang Provincial Natural Science Foundation under Grant No.Y13F020205, No.LY13F020047, Zhejiang Provincial Technical Plan Project (No.2011C11038 and No.2011C13008).

The Tigler SC8200 and the infonix operating system is supported by Infocore Co,.Ltd, Hangzhou, China.

REFERENCES

Feng Wang, Xiaoguang Liu, Gang Wang, and Jing Liu. "Design for Asynchronous and Real-Time Remote Replication System." Journal of Computer Research and Development, Vol. 46 (Suppl.), (2009): 114-121.

Jing Yang, Oiang Cao, Xu Li, Changsheng Xie, and Qing Yang. "ST-CDP: Snapshots in TRAP for Continuous Data Protection." IEEE transactions on computers, Vol. 61, No. 6, June, 2012.

Maohua Lu, Dilip Simha, and Tzi-cker Chiueh. "Scalable Index Update for Block-Level Continuous Data Protection." Sixth IEEE International Conference on Networking, Architecture, and Storage, 2011.

Stephen Smaldone, Grant Wallace, and Windsor Hsu. "Efficiently Storing Virtual Machine Backups." Proceedings of the 5th USENIX conference on Hot Topics in Storage and File Systems, USENIX Association, 2013.

Wei Zhang, Tao Yang, Gautham Narayanasamy, and Hong Tang. "Low-Cost Data Deduplication for Virtual Machine Backup in Cloud Storage." Proceedings of the 5th USENIX Workshop on Hot Topics in Storage and File Systems, June, 2013.

Xiao Li, Yu-an Tan, and Yuanzhang Li. "Snapshot Method for Continuous Data Protection Systems." Journal of Software, Vol. 22, No. 10, (2011): 2523-2537.

Zhichao Li，Kevin M. Greenan，Andrew W. Leung, and Erez Zadok. "Power Consumption in Enterprise-Scale Backup Storage Systems." Proceedings of the 10th USENIX conference on File and Storage Technologies, USENIX Association, 2012.

Yongjian Ren received the PhD degree in Department of Modern Mechanics from Zhejiang University, Hangzhou, China, in 1989. He is currently a professor in computer science in Hangzhou Dianzi University, China. His research interests include Mass Storage, The Disaster Recovery and Backup, and Cloud Computing.

Haoze Jiang is currently the M.S. of Department of Computer Science and Technology in Hangzhou Dianzi University, China. His research interests include Computer Storage Management.

Jilin Zhang is currently the post-doc of Computer Application Technology in Zhejiang University, Hangzhou, China. He serves as an associate professor of software engineering in Hangzhou Dianzi University, China. His research interests include High Performance Computing and Cloud Computing.

Ye Chen received the M.A. degree in Computer Application Technology from Florida Atlantic University, Florida, USA, in 2000. He serves as the CTO of Infocore Co,.Ltd, Hangzhou, China. His research interests include Computer Storage Management.